I/WE CLAIM:

Sub B1

1. A method of changing the bandgap energy in an Indium Gallium Arsenide Phosphide (InGaAsP) semiconductor quantum well structure, wherein the composition fraction for each of Indium, Gallium, Arsenide and Phosphide ranges from zero to one, the method comprising:

   (a) providing a quantum well structure comprising an Indium Gallium Arsenide Phosphide (InGaAsP) quantum well active region; and

   (b) on top of said quantum well structure, providing a first Indium Phosphide layer with vacancy type defects, wherein the vacancy type defects act as slow diffusers; and

   (c) on top of said first Indium Phosphide layer, providing a second Indium Phosphide layer with interstitial type defects, wherein the interstitial defects act as fast diffusers; and

   (d) applying a Rapid Thermal Annealing (RTA) process for controlled diffusion of slow diffusing vacancy type defects in the first Indium Phosphide layer to the Indium Gallium Arsenide Phosphide (InGaAsP) quantum well active region, and applying a Rapid Thermal Annealing (RTA) process for controlled diffusion of fast diffusing interstitial type defects in the second Indium Phosphide layer to the Indium Gallium Arsenide Phosphide (InGaAsP) quantum well active region.

2. A method as defined in claim 1, which includes growing said second Indium Phosphide layer with interstitial type defects above said first Indium Phosphide layer by means of Molecular Beam Epitaxy (MBE).

3. A method as defined in claims 1, which includes applying said Rapid Thermal Anneal (RTA) process for controlled diffusion of said fast diffusing interstitial type defects, thereby providing an increase in the effective bandgap energy of the Indium Gallium Arsenide Phosphide quantum well active region.

4. A method as defined in claim 1, which includes growing said first Indium phosphide layer with slow diffusing vacancy type defects above the upper quaternary layers of the Indium Gallium Arsenide Phosphide (InGaAsP) quantum well structure by means of Molecular Beam Epitaxy (MBE).

5. A method as defined in claim 4, which includes growing said first indium phosphide layer with vacancy type defects using Helium-Plasma assisted Molecular Beam Epitaxy (MBE).

6. A method as defined in claim 5, wherein said Helium-Plasma assisted Molecular Beam Epitaxy includes: exposing said first indium phosphide layer to a flux of Helium particles during Molecular Beam Epitaxy growth.

7. A method as defined in claim 6, wherein exposing said first indium phosphide layer to a flux of Helium particles during Molecular Beam Epitaxy growth provides vacancy type defects within said first indium phosphide layer.

8. A method as defined in claim 1, which includes providing slow diffusing vacancy type defects in the first Indium Phosphide layer, wherein said defects provide deep states within the bandgap of the Indium Gallium Arsenide Phosphide quantum well active region

9. A method as defined in claim 8, wherein said deep states provide reduced carrier lifetimes within the bandgap of the Indium Gallium Arsenide Phosphide quantum well active region.

10. A method as defined in claim 9, wherein reduced carrier lifetimes provide a reduction in carrier recombination times within the bandgap of the Indium Gallium Arsenide Phosphide quantum well active region.

11. A method as defined in claim 8, wherein said deep states provide a mechanism for quenching photoluminescence within the Indium Gallium Arsenide Phosphide quantum well active region.

12. A method of changing the bandgap energy in an Indium Gallium Arsenide Phosphide (InGaAsP) semiconductor quantum well structure, wherein the composition fraction for each of Indium, Gallium, Arsenide and Phosphide ranges from zero to one, the method comprising:

(a) providing a quantum well structure comprising an Indium Gallium Arsenide Phosphide (InGaAsP) quantum well active region; and

(b) on top of the quantum well structure, providing an Indium Phosphide layer with an abundance of point defects, wherein said point defects are donor-like Phosphor antisites or acceptor-like Indium vacancies; and

(c) applying a Rapid Thermal Annealing (RTA) process for controlled diffusion of said interstitial type defects in said Indium Phosphide layer, wherein said interstitial

defects diffuse to the quantum well region.

13. A method as defined in claim 12, which includes growing said Indium Phosphide layer with point defects using Molecular Beam Epitaxy (MBE).

14. A method as defined in claim 13, which includes growing said Indium Phosphide layer by means of a reduced temperature MBE process, such that an abundance of point defects are provided in the Indium Phosphide layer.

15. A method as defined in claim 14, wherein varying the thickness of the grown Indium Phosphide layer changes the bandgap energy in the Indium Gallium Arsenide Phosphide over a range of 0-140nm.

16. A method as defined in claim 15, wherein said bandgap energy changes over said range of 0-140nm in a single thermal anneal step.

17. A device for generating a high speed modulated optical signal, the device comprising: A laser and an electro-absorption modulator integrated within the device, wherein the electro-absorption modulator comprises an Indium Gallium Arsenide Phosphide (InGaAsP) quantum well active region with modified effective bandgap properties.

18. The device as defined in claim 17, wherein the modified effective bandgap properties in the electro-absorption modulator quantum well active region comprises:

(a) deep states that reduce carrier lifetimes and quench photoluminescence within said bandgap; and

(b) an effective bandgap energy increase (Blue Shift) of said quantum well active region.

19. The device defined in claim 18, wherein said deep states, provides non-radiative defect centres within the quantum well active region bandgap of the electro-absorption modulator.

20. The device defined in claim 19, wherein said non-radiative defect centres generate short carrier recombination times within the quantum well active region bandgap of the electro-absorption modulator, thereby causing the electro-absorption modulator to exhibit ultra high-speed response.

21. The device defined in claim 18, wherein said effective bandgap energy increase (Blue Shift) of said quantum well active region, causes transparency of the electro-absorption modulator under zero bias conditions.

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